AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1-2.   (Canceled).

3.   (Currently Amended) A portable radio system comprising:

an internal oscillator; and

an automatic frequency control for detecting a frequency shift of said internal oscillator with reference to a received wave transmitted from a base station and adjusting a frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control; and

A portable radio system as set forth in claim 1, wherein, upon performing calculation, upon performing calculation said detecting of said frequency shift, comprises deriving parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the, where

a signal whose phase is to be calculated the phase is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

4.   (Currently Amended): <u>A portable radio system comprising:</u>

<u>an internal oscillator; and</u>

<u>an automatic frequency control for detecting a frequency shift of said internal oscillator with reference to a received wave transmitted from a base station and adjusting a frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,</u>

<u>wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control; and</u>

~~A portable radio system as set forth in claim 1,~~ wherein, ~~upon performing calculation~~ said detecting of said frequency shift~~,~~ comprises deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components of said signal, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

5-7. (Canceled).

8.   (Currently Amended) A portable radio system employing an automatic

frequency control for detecting a frequency shift of an internal oscillator of a portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, wherein said portable radio equipment comprises;

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when said phase difference derived by said

calculating means is smaller than a predetermined set value, and for narrowing said interval

when said phase difference is greater than said set value;

wherein said two symbols are the same phase when a frequency of said internal oscillator

is correct, and

said calculating means derives a phase difference of said two symbols by multiplying

one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent by employing coordinate rotation digital

computation (CORDIC), said frequency shift calculating means performs calculation within a

range of $\pm \pi$; and

~~A portable radio system as set forth in claim 7,~~ wherein,~~ upon performing calculation~~ said detecting of said frequency shift~~,~~ comprises deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by replacing the~~, where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase,~~ in former stage of said coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = $\pi / 2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -($\pi / 2$)

is performed.

9.   (Currently Amended) A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for widening said interval when said phase difference derived by said calculating means is smaller than a predetermined set value, and for narrowing said interval when said phase difference is greater than said set value;

wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent by employing coordinate rotation digital computation (CORDIC), said frequency shift calculating means performs calculation within a range of $\pm \pi$; and

~~A portable radio system as set forth in claim 7,~~ wherein~~, upon performing calculation~~ said detecting of said frequency shift~~,~~ comprises deriving parameters CORDICi and CORDICq

are derived by using a calculation of said coordinate rotation digital computation by replacing the, where

a signal whose phase is to be calculated the phase is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

10.   (Currently Amended) A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, wherein said portable radio equipment comprises;

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when said phase difference derived by said

calculating means is smaller than a predetermined set value, and for narrowing said interval

when said phase difference is greater than said set value; and

A portable radio system as set forth in claim 5, wherein said control means sets said

interval at a predetermined minimum value when out of synchronization is detected at least from

due to one of a failure of decoding to decode or non-detection of to detect a pilot and not

reaching a failure of power to reach a predetermined level.

11-13. (Canceled).

14.   (Currently Amended) A portable radio system employing an automatic

frequency control for detecting a frequency shift of an internal oscillator of a portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, wherein said portable radio equipment comprises:

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when a value of said frequency shift derived by

said frequency shift calculating means is smaller than a predetermined value and for narrowing

said interval when said value of said frequency shift is greater than said predetermined value;

wherein said two symbols are the same phase when a frequency of said internal oscillator

is correct, and

said calculating means derives a phase difference of said two symbols by multiplying

one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent of coordinate rotation digital computation

(CORDIC), said frequency shift calculating means performs calculation within a range of $\pm \pi$;

and

A portable radio system as set forth in claim 13, wherein, upon performing calculation

said detecting of said frequency shift, comprises deriving parameters CORDICi and CORDICq

are derived by using a calculation of said coordinate rotation digital computation by replacing

the, where

a signal whose phase is to be calculated the phase is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, in former stage of said

coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -($\pi/2$)

is performed.

15.   (Currently Amended) A portable radio system employing an automatic

frequency control for detecting a frequency shift of an internal oscillator of a portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, wherein said portable radio equipment comprises:

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when a value of said frequency shift derived by

said frequency shift calculating means is smaller than a predetermined value and for narrowing

said interval when said value of said frequency shift is greater than said predetermined value;

wherein said two symbols are the same phase when a frequency of said internal oscillator

is correct, and

said calculating means derives a phase difference of said two symbols by multiplying

one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent of coordinate rotation digital computation

(CORDIC), said frequency shift calculating means performs calculation within a range of $\pm \pi$;

and

A portable radio system as set forth in claim 13, wherein, upon performing calculation

said detection of said frequency shift, comprises deriving parameters CORDICi and CORDICq

are derived by using a calculation of said coordinate rotation digital computation by replacing

the, where

a signal whose phase is to be calculated the phase is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said~~

~~coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

16.   (Currently Amended) <u>A portable radio system employing an automatic

frequency control for detecting a frequency shift of an internal oscillator of a portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, wherein said portable radio equipment comprises:

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;</u>

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when a value of said frequency shift derived by

said frequency shift calculating means is smaller than a predetermined value and for narrowing

said interval when said value of said frequency shift is greater than said predetermined value;

and

A portable radio system as set forth in claim 11, wherein said control means sets said

interval at a predetermined minimum value when out of synchronization is detected at least from

due to one of a failure of decoding to decode or non-detection of to detect a pilot and not

reaching a failure of power to reach a predetermined level.

17-18. (Canceled).

19.   (Currently Amended) A portable radio equipment comprising:

an internal oscillator; and

an automatic frequency control for detecting a frequency shift of said internal oscillator

with reference to a received wave transmitted from a base station and adjusting a frequency of

said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation

of arctangent in said automatic frequency control; and

~~A portable radio equipment as set forth in claim 17,~~ wherein, ~~upon performing~~

~~calculation~~ said detecting of said frequency shift~~,~~ comprises deriving parameters CORDICi and

CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by~~

~~replacing the~~, where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase~~, in former stage of said~~

~~coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

20.   (Currently Amended) A portable radio equipment comprising:

an internal oscillator; and

an automatic frequency control for detecting a frequency shift of said internal oscillator

with reference to a received wave transmitted from a base station and adjusting a frequency of

said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation

of arctangent in said automatic frequency control; and

~~A portable radio equipment as set forth in claim 17,~~ wherein, ~~upon performing~~

~~calculation~~ said detecting of said frequency shift, comprises deriving parameters CORDICi and

CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by~~

~~replacing the,~~ where

a signal whose phase is to be calculated the phase with I and Q components of said

signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said~~

~~coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

21-23. (Canceled).

24.   (Currently Amended) A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for widening said interval when said phase difference derived by said calculating means is smaller than a predetermined set value and for narrowing said interval when said phase difference is greater than said set value;

wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying

one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent by employing coordinate rotation digital

computation, said frequency shift calculating means performs calculation within a range of

$\pm \pi$; and

~~A portable radio equipment as set forth in claim 23,~~ wherein, ~~upon performing~~

~~calculation~~ said detecting of said frequency shift, comprises deriving parameters CORDICi and

CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by~~

~~replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said~~

~~coordinate rotation digital computation,~~ a process expressed by:

A frequency error predicting method

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

25.   (Currently Amended) <u>A portable radio equipment employing an automatic</u>

<u>frequency control for detecting a frequency shift of an internal oscillator of own portable radio</u>

<u>equipment with reference to a received wave transmitted from a base station and adjusting the</u>

<u>frequency of said internal oscillator by feeding back said frequency shift to said internal</u>

<u>oscillator, comprising:</u>

<u>calculating means for calculating a phase difference of two symbols taken from a known</u>

<u>data modulated by said base station on the basis of a timing generated by said internal oscillator;</u>

<u>frequency shift calculating means for calculating a frequency shift of said internal</u>

<u>oscillator by dividing said phase difference derived by said calculating means by an interval of</u>

<u>said two symbols; and</u>

<u>control means for widening said interval when said phase difference derived by said</u>

<u>calculating means is smaller than a predetermined set value and for narrowing said interval</u>

<u>when said phase difference is greater than said set value;</u>

<u>wherein said two symbols are the same phase when a frequency of said internal oscillator</u>

<u>is correct, and</u>

<u>said calculating means derives a phase difference of said two symbols by multiplying</u>

<u>one of said two symbols by a complex conjugate of another symbol;</u>

wherein upon calculation of arctangent by employing coordinate rotation digital

computation, said frequency shift calculating means performs calculation within a range of

± π ; and

~~A portable radio equipment as set forth in claim 23,~~ wherein~~, upon performing~~

~~calculation~~ said detecting of said frequency shift~~,~~ comprises deriving parameters CORDICi and

CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by~~

~~replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase~~, in former stage of said~~

~~coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

26. (Currently Amended) A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for widening said interval when said phase difference derived by said calculating means is smaller than a predetermined set value and for narrowing said interval when said phase difference is greater than said set value; and

A portable radio equipment as set forth in claim 21, wherein said control means sets said interval at a predetermined minimum value when out of synchronization is detected at least from due to one of a failure of decoding of non detection of to decode or to detect a pilot and not reaching a failure of power to reach a predetermined level.

27-29. (Canceled).

30.   (Currently Amended) <u>A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:</u>

<u>calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;</u>

<u>frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and</u>

<u>control means for widening said interval when a value of said frequency shift derived by said frequency shift calculating means is smaller than a predetermined value and for narrowing said interval when said value of said frequency shift is greater than said predetermined value;</u>

<u>wherein upon calculation of arctangent by employing coordinate rotation digital computation, said frequency shift calculating means performs calculation within a range of</u> <u>$\pm \pi$; and</u>

~~A portable radio equipment as set forth in claim 29,~~ wherein~~, upon performing calculation~~ <u>said detecting</u> of said frequency shift~~,~~ <u>comprises deriving</u> parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by replacing the,~~ <u>where</u>

a signal whose phase is to be calculated the phase is replaced with I and Q components, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

31.   (Currently Amended) A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when a value of said frequency shift derived by

said frequency shift calculating means is smaller than a predetermined value and for narrowing

said interval when said value of said frequency shift is greater than said predetermined value;

wherein upon calculation of arctangent by employing coordinate rotation digital

computation, said frequency shift calculating means performs calculation within a range of

$\pm \pi$; and

A portable radio equipment as set forth in claim 29, wherein, upon performing

calculation said detecting of said frequency shift, comprises deriving parameters CORDICi and

CORDICq are derived by using a calculation of said coordinate rotation digital computation by

replacing the, where

a signal whose phase is to be calculated the phase is replace with I and Q components of

said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, in former stage of said

coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

32.   (Currently Amended) A portable radio equipment employing an automatic

frequency control for detecting a frequency shift of an internal oscillator of own portable radio

equipment with reference to a received wave transmitted from a base station and adjusting the

frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal

oscillator by dividing said phase difference derived by said calculating means by an interval of

said two symbols; and

control means for widening said interval when a value of said frequency shift derived by

said frequency shift calculating means is smaller than a predetermined value and for narrowing

said interval when said value of said frequency shift is greater than said predetermined value;

and

~~A portable radio equipment as set forth in claim 27,~~ wherein said control means sets said

interval at a predetermined minimum value when out of synchronization is detected ~~at least from~~

due to one of a failure ~~of decoding~~ to decode or ~~non-detection of~~ to detect a pilot and ~~not~~

~~reaching~~ a failure of power to reach a predetermined level.

33-34. (Canceled).

35.   (Currently Amended) A frequency error predicting method comprising:

detecting, employing an automatic frequency control, a frequency shift of an internal

oscillator of portable radio equipment with reference to a received wave transmitted from a base

station; and

adjusting the frequency of said internal oscillator by feeding back said frequency shift to

said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation

of arctangent in said automatic frequency control;

wherein, upon calculation of arctangent, calculation is performed within a range of

$\pm \pi$; and

~~A frequency error predicting method as set forth in claim 34,~~ wherein, ~~upon performing~~

~~calculation~~ said detecting of said frequency shift, comprises deriving parameters CORDICi and

CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by~~

~~replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase ~~, in former stage of said~~

~~coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

36.   (Currently Amended) A frequency error predicting method comprising:

detecting, employing an automatic frequency control, a frequency shift of an internal

oscillator of portable radio equipment with reference to a received wave transmitted from a base

station; and

adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control;

wherein, upon calculation of arctangent, calculation is performed within a range of $\pm \pi$; and

~~A frequency error predicting method as set forth in claim 34,~~ wherein, ~~upon performing calculation~~ said detecting of said frequency shift, comprises deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

37-39. (Canceled).

40. (Currently Amended) <u>A frequency error predicting method employing an automatic frequency control for detecting a frequency shift of an internal oscillator of portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising of steps of:</u>

<u>calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;</u>

<u>calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating step by an interval of said two symbols; and</u>

<u>widening said interval when said phase difference derived by said phase difference calculating step is smaller than a predetermined set value and narrowing said interval when said phase difference is greater than said set value;</u>

<u>wherein upon calculation of arctangent of coordinate rotation digital computation, said frequency shift calculating step performs calculation within a range of $\pm \pi$;</u> and

~~A frequency error predicting method as set forth in claim 39,~~ wherein, ~~upon performing calculation of said frequency shift, in~~ said frequency shift calculating step, further comprises deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said coordinate rotation digital computation ~~by replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said coordinate rotation digital computation,~~ a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi $\quad$ * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

41. (Currently Amended) A frequency error predicting method employing an automatic frequency control for detecting a frequency shift of an internal oscillator of portable

radio equipment with reference to a received wave transmitted from a base station and adjusting

the frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising of steps of:

calculating a phase difference of two symbols taken from a known data modulated by

said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference

derived by said calculating step by an interval of said two symbols; and

widening said interval when said phase difference derived by said phase difference

calculating step is smaller than a predetermined set value and narrowing said interval when said

phase difference is greater than said set value;

wherein upon calculation of arctangent of coordinate rotation digital computation, said

frequency shift calculating step performs calculation within a range of $\pm \pi$; and

~~A frequency error predicting method as set forth in claim 39,~~ wherein, ~~upon performing~~

~~calculation of said frequency shift, in~~ said frequency shift calculating step, further comprises

deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said

coordinate rotation digital computation ~~by replacing the~~, where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components,

and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, ~~in former stage of said~~

~~coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

42.   (Currently Amended) A frequency error predicting method employing an

automatic frequency control for detecting a frequency shift of an internal oscillator of portable

radio equipment with reference to a received wave transmitted from a base station and adjusting

the frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising of steps of:

calculating a phase difference of two symbols taken from a known data modulated by

said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference

derived by said calculating step by an interval of said two symbols; and

widening said interval when said phase difference derived by said phase difference

calculating step is smaller than a predetermined set value and narrowing said interval when said

phase difference is greater than said set value; and

~~A frequency error predicting method as set forth in claim 37,~~ wherein said interval

controlling step sets said interval at a predetermined minimum value when out of

synchronization is detected ~~at least from~~ due to one of a failure ~~of decoding~~ to decode or ~~non-~~

~~detection of~~ to detect a pilot and ~~not reaching~~ a failure of power to reach a predetermined level.

43-45. (Canceled).

46.   (Currently Amended) A frequency error predicting method employing an

automatic frequency control for detecting a frequency shift of an internal oscillator of portable

radio equipment with reference to a received wave transmitted from a base station and adjusting

the frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising the steps of:

calculating a phase difference of two symbols taken from a known data modulated by

said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference

derived by said calculating step by an interval of said two symbols; and

widening said interval when a value of said frequency shift derived by said frequency

shift calculating step is smaller than a predetermined value and for narrowing said interval when

said value of said frequency shift is greater than said predetermined value;

wherein upon calculation of arctangent of coordinate rotation digital computation, said

frequency shift calculating step performs calculation within a range of $\pm \pi$; and

A frequency error predicting method as set forth in claim 45, wherein, upon performing

calculation of said frequency shift, in said frequency shift calculating step, further comprises

deriving parameters CORDICi and CORDICq are derived by using a calculation of said

coordinate rotation digital computation by replacing the, where

a signal whose phase is to be calculated the phase is replaced with I and Q components,

and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, in former stage of said

coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

47.   (Currently Amended) A frequency error predicting method employing an

automatic frequency control for detecting a frequency shift of an internal oscillator of portable

radio equipment with reference to a received wave transmitted from a base station and adjusting

the frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising the steps of:

calculating a phase difference of two symbols taken from a known data modulated by

said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference

derived by said calculating step by an interval of said two symbols; and

widening said interval when a value of said frequency shift derived by said frequency

shift calculating step is smaller than a predetermined value and for narrowing said interval when

said value of said frequency shift is greater than said predetermined value;

wherein upon calculation of arctangent of coordinate rotation digital computation, said

frequency shift calculating step performs calculation within a range of $\pm$ π ; and

~~A frequency error predicting method as set forth in claim 45,~~ wherein~~, upon performing~~

~~calculation of said frequency shift, in~~ said frequency shift calculating step~~,~~ further comprises

deriving parameters CORDICi and CORDICq ~~are derived~~ by ~~using a calculation of~~ said

coordinate rotation digital computation ~~by replacing the,~~ where

a signal whose phase is to be calculated ~~the phase~~ is replaced with I and Q components

of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase~~, in former stage of said~~

~~coordinate rotation digital computation~~, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

48.   (Currently Amended) A frequency error predicting method employing an

automatic frequency control for detecting a frequency shift of an internal oscillator of portable

radio equipment with reference to a received wave transmitted from a base station and adjusting

the frequency of said internal oscillator by feeding back said frequency shift to said internal

oscillator, comprising the steps of:

calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating step by an interval of said two symbols; and

widening said interval when a value of said frequency shift derived by said frequency shift calculating step is smaller than a predetermined value and for narrowing said interval when said value of said frequency shift is greater than said predetermined value; and

~~A frequency error predicting method as set forth in claim 43,~~ wherein said interval controlling step sets said interval at a predetermined minimum value when out of synchronization is detected ~~at least from~~ due to one of a failure ~~of decoding~~ to decode or ~~non-detection of~~ to detect a pilot and ~~not reaching~~ a failure of power to reach a predetermined level.

49.   (New) A portable radio system as set forth in claim 3, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

50.   (New) A portable radio system as set forth in claim 8, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

51.   (New) A portable radio system as set forth in claim 14, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

52.   (New) A portable radio equipment as set forth in claim 19, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

53.   (New) A portable radio equipment as set forth in claim 24, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

54.   (New) A portable radio equipment as set forth in claim 30, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

55.   (New) A frequency error predicting method as set forth in claim 35, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

56.   (New) A frequency error predicting method as set forth in claim 40, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

57.   (New) A frequency error predicting method as set forth in claim 46, wherein said received wave transmitted from said base station has a higher precision of frequency than said internal oscillator.

58.   (New) A system or equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises;

a first circuit which calculates a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

a second circuit which calculates a frequency shift of said internal oscillator by dividing said phase difference derived by said first circuit by an interval of said two symbols; and

a third circuit which widens said interval when said phase difference derived by said calculating means is smaller than a predetermined set value, and narrows said interval when said phase difference is greater than said set value;

wherein upon calculation of arctangent by employing coordinate rotation digital

computation (CORDIC), said second circuit performs calculation within a range of $\pm \pi$; and

wherein said detecting of said frequency shift comprises deriving parameters CORDICi

and CORDICq by said coordinate rotation digital computation, where

a signal whose phase is to be calculated is replaced with I and Q components of said

signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = $\pi /2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -($\pi /2$)

is performed.

59.   (New) A system or equipment employing an automatic frequency control for

detecting a frequency shift of an internal oscillator of a portable radio equipment with reference

to a received wave transmitted from a base station and adjusting the frequency of said internal

oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable

radio equipment comprises;

a first circuit which calculates a phase difference of two symbols taken from a known

data modulated by said base station on the basis of a timing generated by said internal oscillator;

a second circuit which calculates a frequency shift of said internal oscillator by dividing

said phase difference derived by said first circuit by an interval of said two symbols; and

a third circuit which widens said interval when said phase difference derived by said

calculating means is smaller than a predetermined set value, and narrows said interval when said

phase difference is greater than said set value;

wherein upon calculation of arctangent by employing coordinate rotation digital

computation (CORDIC), said second circuit performs calculation within a range of $\pm \pi$; and

wherein said detecting of said frequency shift comprises deriving parameters CORDICi

and CORDICq by said coordinate rotation digital computation, where

a signal whose phase is to be calculated is replaced with I and Q components of said

signal, and

in calculation of said coordinate rotation digital computation, when a parameter for

outputting a final angle by adding angles per taps is set as phase, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = - π

is performed.

60.   (New) A system or equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises;

a first circuit which calculates a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

a second circuit which calculates a frequency shift of said internal oscillator by dividing said phase difference derived by said first circuit by an interval of said two symbols; and

a third circuit which widens said interval when said phase difference derived by said calculating means is smaller than a predetermined set value, and narrows said interval when said phase difference is greater than said set value; and

wherein said third circuit sets said interval at a predetermined minimum value when out of synchronization is detected due to one of a failure to decode or to detect a pilot and a failure of power to reach a predetermined level.

61.   (New) A system or equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises:

a first circuit which calculates a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

a third circuit which calculates a frequency shift of said internal oscillator by dividing said phase difference derived by said first circuit by an interval of said two symbols; and

a third circuit which widens said interval when a value of said frequency shift derived by said second circuit is smaller than a predetermined value, and narrows said interval when said value of said frequency shift is greater than said predetermined value;

wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said first circuit derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent of coordinate rotation digital computation (CORDIC), said second circuit performs calculation within a range of $\pm \pi$; and

wherein said detecting of said frequency shift comprises deriving parameters CORDICi and CORDICq by said coordinate rotation digital computation, where

a signal whose phase is to be calculated is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi   * -1.0

phase = π /2

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = -(π /2)

is performed.

62.   (New) A system or equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises:

a first circuit which calculates a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

a third circuit which calculates a frequency shift of said internal oscillator by dividing said phase difference derived by said first circuit by an interval of said two symbols; and

a third circuit which widens said interval when a value of said frequency shift derived by said second circuit is smaller than a predetermined value, and narrows said interval when said value of said frequency shift is greater than said predetermined value;

wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said first circuit derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol;

wherein upon calculation of arctangent of coordinate rotation digital computation (CORDIC), said second circuit performs calculation within a range of $\pm \pi$; and

wherein said detection of said frequency shift comprises deriving parameters CORDICi and CORDICq by said coordinate rotation digital computation, where

a signal whose phase is to be calculated is replaced with I and Q components of said signal, and

in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq   * -1

phase = π

-48-

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.